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Dr. Lloyd observed that there could be no doubt of the excellence of the observations recorded in the foregoing communication: they afforded abundant proof, both of the perfection of the instruments employed by Professor Hansteen, and of his skill in using them. But the fact that the diurnal variation of the inclination has not been observed with the English dip circles could not, he thought, be fairly adduced in proof of their inferiority to the French instruments; inasmuch as this element is obtained by us more completely by other instrumental means. By means of the balance magnetometer (combined with the bifilar magnetometer) not only the range, but the *whole course* of the diurnal variation of the inclination, has been completely determined at Dublin; and the same thing is true of other places at which both these instruments have been employed. In fact, it is in this circumstance that the advantage of the British observatories over those of the Continent mainly consists, the daily observations of the latter being limited to two of the three magnetic elements.

Dr. Lloyd believed that it was unnecessary for him to enter further into the question of the accuracy attainable by the dip circles of the form now used by English observers, as the subject would be fully discussed by Mr. Stoney in a paper to be read by him to the Academy that evening. He would merely observe that Professor Hansteen seemed to be under a misconception in supposing that it was necessary, with these instruments, to observe the needle *at rest*. By the help of a small divided scale in the focus of each of the microscopes, the wires may be either *placed* in the position of equilibrium, while the needle itself is in motion, or (the microscopes being fixed) the deviation of the wires from that position may be observed, and added, with its proper sign, to the readings of the verniers. This simple addition had, in fact been made in the original instrument of this construction, which was made by Mr. Barrow for Dr. Lloyd, and according to his specifications.

Mr. G. J. Stoney read a paper—

ON THE DEGREE OF ACCORDANCE WHICH MAY BE ATTAINED IN OBSERVATIONS MADE WITH DR. LLOYD'S DIP CIRCLES.

In fixed magnetic observatories the instruments may be mounted with every appliance, however cumbersome, which contributes to accuracy; but when we mean to carry an instrument from station to station, making observations with it at each, the necessity that it be of moderate size, and not easily injured or thrown out of adjustment, debars us from many arrangements which we might otherwise make. Yet with such travelling instruments very considerable degrees of accordance have been attained, and, as I think, much more accuracy is within our reach, by attention to a small mechanical detail.

In the most sensitive of the travelling dip circles for use on shore, the needle rests by a thin and most carefully constructed transverse axis on two smooth horizontal pieces of agate, upon which the axis rolls without rubbing as the needle oscillates before coming to rest. A wonderful degree of delicate mechanical accuracy has been attained in the construction of this minute cylindrical axes, an accuracy which would even have gone beyond the requirements of the instrument, had not Dr. Lloyd removed a source of magnetic derangement, by which all the earlier observations were disturbed.

This disturbance arose from the graduated circle of the instrument, which used formerly to be brought as close to the needle as possible. Dr. Lloyd was led, from an analysis of the observations he made in the magnetic survey of 1828, closely to test this circle; and he found that, though made of materials which were supposed to be non-magnetic, it exhibited a trace of magnetism which injuriously affected the needle. He accordingly removed the circle to a sufficient distance from the needle, and ascertained the position of the needle by two microscopes carried by an arm which traverses the circle, and thus at once got rid of the magnetic disturbance, introduced greater accuracy into the reading of the position of the needle, and secured other important advantages, into which we need not now enter.

This has again made the *mechanical* arrangements of the instrument the more defective; and I propose now to give some account of the degree of accordance which may be expected with the dip circle with which a magnetic survey of the southern half of Ireland was made in 1858, and of a slight modification of the apparatus for placing the axis of the needle on the agate planes, which would, I believe, render it possible to secure a higher degree of accordance.

In determining the magnetic dips at any station, the axis of the needle is placed in eight distinct positions upon the upper horizontal edges of parallel agate plates, on which it can roll freely, and the position of each end of the needle observed about three times in each of the eight positions.

Between each pair of readings the needle is lifted and replaced by a little frame, designed to lay the needle down with suitable precision on the edges of the agate plates. Each time that the magnet is replaced by this frame, it swings about for a short time, and the position it assumes when these oscillations are over is recorded.

The axis of the magnet is thick in the centre, where it passes through the magnet. The ends, where it is to rest on the agate plates, are most carefully turned down to a needle-like thinness; and on either side, between the thick and the thin parts, there are short pieces of intermediate thickness, which are to be placed in Ys, with which the lifting frame is fitted. The endlong adjustment of the axis is effected by the same Ys, since the thick part of the axis falls between them, resting against the sloped inner sides of the Ys by its cone-shaped ends. This little frame thus discharges distinct offices; it brings the proper parts of the axis of the needle down upon the agate plates, it places them upon the right parts of the edges of the agate plates, and it sets the magnet swinging between each pair of readings, since the frame turns on pivots at one end, and thus imparts a motion of rotation to the magnet in depositing it. When the glass case of the instrument is shut, the observer can raise and lower the magnet from without by this lifting frame.

This piece of apparatus needs to be manipulated with care. If the needle be lowered too rapidly, it comes down with a sensible impact against the hard agate plates, and hops upon them, thus altogether deranging the adjustments which the frame was designed to secure. If, on the other hand, it be lowered too slowly, there are two sources of mischief. The two ends of the axis do not reach the agates at strictly the same instant; and in the intervening moment one end of the axis is still resting in its Y, while the other is rolling on the agate plate, and disturbing the adjustment. But the chief source of error seems to arise from the axis receiving a slight brush from the Ys in parting from them. This arises in a variety of ways, and can be reduced to its minimum only after some practice. There are some positions of the needle in which, upon some days, the effects of this friction can, by careful manipulation, be reduced to an insensible amount;* but there are other positions of the needle in which I found it impracticable, by any care or patience, to evade it; and the slight alteration of the proportions of the parts, due to the differences of temperature from one day to another, is enough to make it sometimes very troublesome in almost all positions of the needle. These remarks will help to show that which I am anxious to insist on, that this part of the instrument deserves all the care the maker can bestow on it.

As an illustration, I will transcribe two complete observations taken at the same station on consecutive days,—the first of which happened to be more than usually free from this source of error, and in the second of which it was particularly troublesome.

Parsonstown (*Lord Rosse's Demesne*); *August* 24, 1858; *from* 2¾ *to* 3½ *P.M.*

Poles Direct. A. North End.		Poles Reversed. B. North End.	
E. Limb.	W.	W. Limb.	E.
70° 24′	109° 60′	109° 44′	70° 4′
23	59	44	5
24	60	44	5
31	60	51	18
30	60	51	18
30	60	52	17
69° 43′	109° 32′	109° 58′	70° 16′
43	32	59	15
43	31	59	14
53	36	59	21
53	36	59	20
53	35	58	20
Mean of Means or Dip = 70° - 10′·44.			
Dip corrected for daily range, 70 - 11·4.			

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* I. e. insensible in an instrument reading only to minutes.

Same Station, August 25, 1858; *from* 9^h 40^m *A. M., to* 10½.

Poles Direct. B. North End.		Poles Reversed. A. North End.	
E. Limb.	W.	W. Limb.	E.
70° 6′	109° 43′	109° 57′	70° 28′
6	44	57	30
8	43	58	30
17	48	56	33
18	49	57	36
19	49	57	36
70° 20′	109° 59′	109° 27′	69° 40′
18	58	28	40
20	58	25	40
23	57	31	51
21	57	31	51
24	57	29	52

Mean of Means or Dip = 70° 12′·75
Dip corrected for daily range, 70 10′· 4

In the sixteen sets of readings which make up the observation of the 24th August, that least embarrassed by the injurious action of the Ys, there is but one case in which this discordance amounts to 2′, while there are four cases of complete accordance. In the eleven others, a difference of one minute of arc occurred. On the other hand, in the observation of the 25th August, but two cases of complete accordance will be found, while the difference three times rises to 3′, and in five other cases it is 2′.

The injurious effect of the hitching produced by the Ys is equally apparent, if, instead of scrutinizing the individual observations, we combine parts of different observations, so as to bring out numbers which ought to be identical in sets. I have done this in various ways with the series of observations made in the survey of the southern half of Ireland in 1858, and found in several instances, instead of identical numbers, differences of one or two minutes, and occasionally, though rarely, of three minutes. These differences are doubtless in part due to magnetical causes; but they clearly point to a mechanical origin also, since they lean in a marked manner towards those positions of the needle in which the hitching of the Ys was most troublesome.

If anything else be necessary to show how much dip observations are effected by a careless design or construction of the lifting apparatus, it will be found in the astonishing, and to me quite unexpected, accuracy with which the needle will roll back to its position when in any fair way displaced from it. This was tested by fastening a small plane mirror to the side of the needle with white lead, and counterpoising it with a little lump of bees' wax, so that when the needle was placed on its agate plates, the reflected image of one of Gauss's scales could be observed by a telescope. The scale was so placed that a millimetre on it corresponded to a minute of arc, and thus 10ths of a minute could be easily read by estimation. These dispositions were made in the small observatory of Trinity College for absolute determinations, in which tremors were wholly avoided, and it was possible to keep the instrument undisturbed for several days. From the observations made there, it appeared that, with a needle rolling on plates of agate, we can follow the daily range with great precision, and observe occasional disturbances, of which many were seen from one to six or eight tenths of a minute; and that when the needle is artificially swung by the attraction of a key through ranges varying from three minutes to four degrees, it returns to its position certainly within the tenth of a minute, and probably within a very small fraction of the tenth of a minute.

Hence it is plain, that if we can bring the apparatus for laying down and removing the needle to a state of mechanical perfection corresponding with that of the axis, we shall be able to use dip needles rolling on agate plates for many purposes for which they have hitherto been supposed not capable of affording determinations of the required degree of accuracy, but for which they are otherwise eminently suited.

It appears essential that the endlong adjustment should be given to the axis by a part of the apparatus distinct from the Ys. Perhaps it could be successfully made by a little edge of agate mounted so as to rise into a carefully turned V-shaped groove in the thick part of the axis. It also appears to me that the Ys should be brought to bear on the carefully turned cylindrical ends of the axis, and mounted so that they could be easily adjusted to let down the two ends of the axis strictly at the same moment; and that each Y should be formed of two plates of agate, worked to a rounded edge, and placed at an angle as obtuse as is consistent with insuring that the axis drop always to the bottom of the Y. This would very much assist the Ys to disengage themselves completely and abruptly from the axis as soon as it comes in contact with the edges on which it is to roll. I should also prefer that the frame carrying the Ys should rise vertically, and not turn on a pivot, which communicates mechanically, and always in the same direction, a rotation to the magnet in placing it on the agate plates. A swing, to be communicated afterwards by magnetic influence from without, would seem to be much better. Of course, attention should be given to the parts by which this vertical motion is to be given, to make it smooth and without shake.

With attention to these details, some of which I have tested with very promising results, it seems likely that a dip circle might be made which should allow the needle to be removed from the instrument, and replaced, without risk of any error exceeding a few seconds.

Fifteen drawings of Irish antiquities, or of things in different museums considered illustrative of ancient weapons found in Ireland, were presented by Mr. G. V. Du Noyer, as an addition to the collection of similar drawings already deposited by that gentleman in the Academy.

Two MS. volumes of a Journal kept in Dublin from 1801–4, and the Journal of a Tour in Ireland, &c., in 1804, in three volumes, were presented to the Library by Mr. James Tighe.

Thanks were returned to the donors.

The Academy then adjourned.

MONDAY, JUNE 24, 1861.

The Very Rev. Dean Graves, D. D., President, in the Chair.

The Rev. J. H. Todd, D. D., read a paper on some additional leaves of the Book of Lismore, recently recovered by his Grace the Duke of Devonshire, and exhibited the MS., in its collective form.

It was Resolved,—That the special thanks of the Academy be returned to his Grace the Duke of Devonshire for the opportunity afforded to its members of becoming acquainted with the contents of the Book of Lismore, through the Rev. Dr. Todd's description, and of personally inspecting this very curious and valuable manuscript.

Sir W. R. Hamilton, LL. D., read a paper—

ON GEOMETRICAL NETS IN SPACE.

[1.] When any five points of space, ABCDE, are given, whereof no four are supposed to be complanar, we can connect any two of them by a right line, and the three others by a plane, and determine the point in which these last intersect each other: *deriving* thus a system of *ten lines* Λ_1, *ten planes* Π_1, and *ten points* P_1, from the *given* system of *five points* P_0, by what may be called a *First Construction.*

We may next propose to determine all the new and distinct lines Λ_2, and planes Π_2, which connect the ten derived points P_1, with the five given points P_0, and with each other; and may then inquire what new and distinct points P_2 arise, as intersections* $\Lambda \cdot \Pi$ of lines and planes already obtained: all *such* new lines, planes, and points being said to belong to a *Second Construction.* And then we might proceed, on the same plan, to a *Third* Construction, and to indefinitely many others following: building up thus what Professor *Möbius,* in his *Barycentric Calculus,*† has proposed to call a *Geometrical Net in Space.*

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* Intersections $\Lambda \cdot \Lambda$ of *line with line* (when complanar) are *included* in this class $\Lambda \cdot \Pi$; and intersections $\Pi \cdot \Pi \cdot \Pi$ of *three distinct planes,* when *not* included at this stage, may be reserved for a *subsequent construction,* in which they naturally offer themselves, as of the standard form $\Lambda \cdot \Pi$.

† Der Calcul Barycentrische, Leipzig, 1827, p. 291. Some first results connected with the subject were given, according to the writer's recollection, in a Memoir by *Carnot* on *Transversals,* to which he cannot at present refer.